

beam to deliver energy to clear the portion of the perimeter of the pool of molten material of volatile impurities that evaporate from the pool of molten material and recondense on the perimeter.

Remarks

Summary of the Office Action

Claims 1-12 were pending.

Claims 1-12 have been rejected under 35 U.S.C. § 102(b) as being anticipated by either of Joseph U.S. patent No. 5,503,655 (“Joseph”) or Entrekin et al. U.S. patent No. 4,838,340 (“Entrekin”). Claims 1-6 have also been similarly rejected as anticipated by either Harker U.S. patent No. 4,932,635 (“Harker I”) or Harker et al. U.S. patent No. 4,961,776 (“Harker II”). Further, claims 2-6 have been objected to under 37 C.F.R. 1.75(c) as having improper dependent forms.

Applicants’ Reply

Applicants respectfully traverse the prior art rejections and the 37 C.F.R §1.75 objections.

37 C.F.R §1.75 objections

Applicants have amended claims 1-7 to clarify the invention and to address the 37 C.F.R §1.75 objections. In particular, each of the dependent claims 2-6 now recites a specific structural limitation that “the programmable device comprises a program which can be executed so that” the desired properties of the respective claim are obtained.

Applicants respectfully submit that amended claims 2-6 properly limit the apparatus of claim 1 and conform to all requirements of 37 C.F.R §1.75.

Prior art rejections

Applicants have improved upon prior art cold hearth refining apparatus and processes. Claims 1-12 are directed to the improved cold hearth refining apparatus. Claim 7 -12 are directed to the improved cold hearth refining apparatus and methods.

Independent claim 1

The cold hearth refining apparatus, according to claim 1, includes two conventional elements — (a) a cold hearth which holds a pool of molten material, and (b) a select first electron gun. The position and the structural/operational characteristics of this electron gun are selected so that electron beams generated by this electron gun have sufficient power and direction to keep the material in the pool in its molten state.

The “improved” apparatus, according to claim 1, further includes new element (c): a second electron gun and a programmable controller deployed in a “skull wing inhibiting configuration.” The second electron gun’s geometric position relative to the cold hearth and the second electron gun’s power specifications namely voltage, current and pulse rate specifications are selected so that the skull wing inhibiting configuration can provide an electron beam that sweeps along at least a portion of the perimeter of the pool of molten material [melted by the first electron gun] to inhibit formation of skull wings at the edges of the pool.

Applicants respectfully submit that this last feature of claim 1 is not shown, taught or suggested by the cited prior art references — Joseph, Entrekin, Harker I and Harker II. In particular, the cited references do not show, teach or suggest the particular “skull wing inhibiting configuration” element recited in claim 1 (i.e., a second electron gun and co-deployed programmable controller with the second electron gun’s geometric position

relative to the cold hearth and the second electron gun's power specifications namely voltage, current and pulse rate specifications are selected so that the skull wing inhibiting configuration can provide an electron beam that sweeps along at least a portion of the perimeter of the pool of molten material to inhibit formation of skull wings at the edges of the pool of molten metal).

Joseph, Entrekin, Harker I and Harker II describe only the conventional elements (a) and (b) of claim 1. As noted in the previous Reply, Joseph describes a low cost production furnace (FIG. 1) to process titanium slag. Joseph deploys conventional electron beam configurations to heat the surface of the titanium slag to form or reheat molten pools of liquid metal (See e.g., FIG. 1 electron beam guns 24 in chambers 100 and 200, col. 5 lines 30- 42, lines 48-50).

Now, applicants note that the portion of Joseph (i.e., col. 5 lines 30-42) cited by the Examiner (see Office Action, page 2 bottom) relate to conventional "bulk melting" operation, and not to any "evaporating impurities that are collected on the pool edge". (See col. 5 lines 39-21: "the outgassing of the molten mixture [bulk pool] volatilizes . . . impurities which are collected on the cooled grids mounted above the hearth")

Joseph does not show, teach or suggest a skull wing inhibiting configuration that is required by claim 1.

As noted in the previous Reply, Entrekin describes continuous casting of fine grain ingots. Like Joseph, Entrekin deploys conventional electron beam configurations to heat "a central portion" and "raise the temperature" of the molten liquid metal. (See e.g., FIGS 1 and 2, col. 4 lines 26-52, claim 2, etc.).

Here, applicants further note that the portion of Entrekin (i.e., col. 5 lines 30-42) cited by the Examiner (see Office Action, page 3 top) relates to conventional “bulk melting” operation, and not to any “evaporating impurities that are collected on the pool edge”. (See col. 4 lines 27-36 “the directed energy input devices are controlled . . . to make certain that the [bulk] molten material contains no solid particles . . . [And] to raise the temperature of the [bulk] material in the pool”).

Like Joseph, Entrekin does not show, teach or suggest a skull wing inhibiting configuration required by claim 1.

Again as noted in the previous Reply, Harper I and II both describe directed energy input devices 15 designed to form or reheat molten pools of [Bulk] liquid metal. (See e.g., Harper I, FIG. 1, col. 2 lines 47-63: “energy beams 15 directed to desired regions of the hearth to heat material 14 to be melted,” “one of electron beams 16 is concentrated on raw material 14 in a melting region 17 . . . so as to melt that material,” etc.).

Applicants note that the portions of Harker I and II (i.e., col. 2 lines 45-61) cited by the Examiner (see Office Action, page 3 middle) relates to conventional “bulk melting” operation, and not to “evaporating impurities that are collected on the pool edge.. Applicants note that the “desired manner” which is mentioned at col. 5 line 53 for controlling the electron beam, does not refer to “any” arbitrary desirable manner, but specifically refers to the desired regions to heat the [bulk] material 14 to be melted (see preceding lines 50-53). Applicants also note that the Harker patents, which clearly describe the formation of solid “skulls” to confine the pool of [bulk] molten material, do not address the issue of skull wing formation and inhibition

Thus, the cited references do not show the particular “skull wing inhibiting configuration,” which as recited in claim 1 includes “a second electron gun and a programmable device coupled to the electron gun, wherein the second electron gun’s geometric position relative to the cold hearth and the second electron gun’s power specifications namely voltage, current and pulse rate specifications are selected so that the skull wing inhibiting configuration can provide an electron beam that sweeps along at least a portion of the perimeter of the pool of molten material to inhibit formation of skull wings at the edges of the pool of molten metal”.

Applicants respectfully submit that the recitation of claim 1 describing “skull wing inhibiting configuration,” is a structural limitation, for example, on the type, structure and specifications of the electron gun used and not merely a limitation on the manner of using an arbitrary electron gun.

Accordingly, claim 1 is patentable over the cited references.

Independent claim 7

Applicants are unclear why Claim 7 has been rejected in the Office Action, as none of the cited references describe or provide any method for solving the problem of skull wing formation.

As previously submitted, applicants’ improved cold hearth refining method involves perimeter cleaning of a pool of molten material. This according to claim 7, requires sweeping a portion of the perimeter of the liquid pool with an electron beam so that volatile impurities that evaporate from the pool of molten material and recon dense on the perimeter are dispersed.

As discussed above with reference to claim 1, the cited references describe only heating of material (e.g., central portions) to form or reheat [bulk] pools of molten material. (See e.g., Joseph col. 5 lines 28-51, and Entekin col. 4 lines 26-36). None of the cited references describes perimeter cleaning using an electron beam. In particular, the cited references do not show "sweeping a portion of the perimeter of the liquid pool with an electron beam so that volatile impurities that evaporate from the pool of molten material and recondense on the perimeter are dispersed." Accordingly, claim 7 is patentable over the cited references.

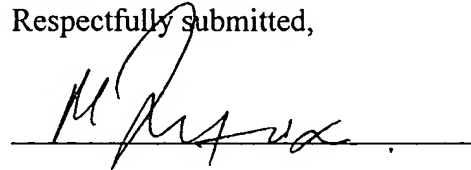
Dependent claims 2-6 and 8-12

Dependent claims 2-6 and 8-12 are patentable over the cited prior art for at least the same reasons that their respective parent claims 1 and 7 are patentable as discussed above.

Conclusion

Applicants respectfully submit that this application is now in condition for allowance. Reconsideration and prompt allowance of which are requested. If there are any remaining issues to be resolved, the applicants request that the Examiner contact the undersigned attorney for a telephone interview.

Respectfully submitted,



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